# Program DIMAD: Vectorization, Links with DA, LIELIB and COSY-∞

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*Abstract*

Further adequate analysis of the stability properties of the KAON Factory rings will require the tracking of particles for at least 20 thousand turns, a good analysis of the tracking results and a flexible tool to analyse and correct coupling resonances. This paper describes the approach followed to achieve those goals with the programs DIMAD, DA, LIELIB and COSY-∞.

## I. INTRINSIC SPEED INCREASE IN DIMAD

The use of the symplectic tracking option is essential when tracking for more than 10 thousand turns around a ring with strong sextupoles. The symplectic tracking algorithm was simplified and optimized to increase its computing efficiency. The next most time onerous operation is the administration of the alignment errors and field errors (multipolar content) and the subsequent orbit and tune correction procedures. This overhead is now reduced considerably by the creation (by DIMAD) of a file containing all the prepared data for a corrected lattice. All the error information about each element is stored individually. A new program (DIMFAST) uses the information contained in this file to compute particle coordinates along the lattice as required by the problem studied. The overall factor of the time gain is 2.5.

## II. VECTORIZATION

The procedure introduced in the previous section is ideal for the vectorization of the tracking process because the tracking routine contains no calls to other subroutines and contains a very small number of decision statements. This makes the vectorization near optimal. Using the vector option of the compiler FORTVS2 of the IBM computer at the Univ. of Victoria, we obtain another time gain factor 2.5.

## III. LINK BETWEEN THE DA PACKAGE AND DIMAD

The DA package is the computer code, developed by Martin Berz [1], which determines the value of map and all its derivatives to a fixed but arbitrary order. As for the vectorization, the existence of the detailed lattice file made the use of DA very straightforward. It is now possible to obtain a DA-map to order 10 in six variables that is consistent with the DIMAD computations. Indirectly this provides the capability of producing a DA-map of a lattice defined by the standard (MAD) input.

## IV. LINK WITH LIELIB AND COSY-∞

The DA-map produced by the DIMFAST program can be read by the program LIELIB based on the theory developed by Berz, Forest and Irwin [2]. It can also be read by the program COSY∞ written by Martin Berz [3]. Among the analysis that can be performed by LIELIB and COSY, by different mathematical formalisms, let us mention the momentum dependence of the tunes and the twiss parameters, their amplitude dependence and the determination of the resonance amplitude coefficients.

## V. RESULTS, COMPARISONS AND AVAILABILITY

The momentum dependence of the tunes and twiss parameters can be computed in DIMAD by the determination of closed orbits and their associated linearized motion. A polynomial expansion of the momentum dependence is then obtained by a least squares fit procedure. The results for two machines (EROS using a third integral resonance for extraction of an electron beam and the B ring of the KAON Factory, with all the errors) were calculated and compared with the results provided by LIELIB and COSY. The on momentum values coincide to an accuracy of $10^{-5}$. An accuracy of $10^{-3}$ is obtained up to order 3, and an accuracy of $10^{-2}$ is maintained up to order 6. Further tests are planned to compare the results of the amplitude dependence of the tunes and the twiss parameters. The new version of DIMAD and the associated program DIMFAST will be released in December, 1991, following satisfactory tests and the installation of more auxiliary routines.

## VI. ACKNOWLEDGEMENTS

## VII. REFERENCES

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[3] M. Berz, "Computational Aspects of Design and Simulation : COSY INFINITY", Nucl. Instrum. Methods, Proc. *Charged Particle Optics III* (1990).